JUNKING ASTRONOMY JARGON

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ABSTRACT: My book, *The Edge of the Sky* tells the story of the All-There-Is (the Universe) as seen through the eyes of a Student-Woman (a female scientist) spending a night of solitude with Big-Seer (a giant telescope), trying to unlock the mystery of dark matter. All of this using only the most common 1,000 words in English. In this paper I reflect back on why and how I chose this format and I present the lessons I learnt in trying to explain the entire All-There-Is this way.

A momentous discovery... or is it?

In 1965 Arno Penzias and Robert Wilson published a short article in the *Astrophysical Journal*.[1] Barely over a page long, it was entitled: 'A measurement of excess antenna temperature at 4080 Mc/s'. Behind this cryptic title lurked one of the greatest discoveries of all times: they had found the cold radiation left over from the Big Bang, evidence that the Universe had a beginning in time. Not something you would have guessed from the title.

Fast-forward to a more recent occasion, when on July 4th, 2012, Joe Incandela, the spokesperson for the CMS experiment at CERN, announced to a packed auditorium: 'If we combine the ZZ and gamma-gamma, in the region of 125 GeV they give a combined significance of 5 standard deviations!'[2] As everybody cheered (and Peter Higgs shed a few tears), it was not immediately obvious to anybody but the particle physicists in the room what the significance of this was. What Incandela was saying was that they had discovered the Higgs boson, the 'God particle' that gives mass to all other particles.

For the public at large to partake in these momentous discoveries, nothing short of a translation would do. Fundamental science often deals with very esoteric concept, far removed from our everyday experience. The technical language (often imbued with mathematics) that scientists use to describe their

[1] Penzias, A.A. & Wilson, R.W., A Measurement of Excess Antenna Temperature at 4080 Mc/s., Astrophysical Journal, vol. 142, p.419-421 (1965)

[2] CERN Press Release, 'CERN experiments observe particle consistent with long-sought Higgs boson', 04 July 2012, online: http://press.cern/press-releases/2012/07/cern-experiments-observe-particle-consistent-long-sought-higgs-boson (accessed Jan 4th 2017); Joe Incandela, 'Status of the CMS SM Higgs Search', Talk given at CERN on July 4th 2012, online:https://cms-docdb.cern.ch/cgi-bin/PublicDocDB/RetrieveFile?docid=6125&filename=CMS_4July2012_Incandela.pdf (accessed Jan 4th 2017)

object of study is unhelpful in connecting with our understanding of the world. It would be better if precision was somewhat eschewed in favour of better communication: a translation of difficult ideas into their basic elements that can better put them in contact with our experiences at the human scale.

Public communication enemy No 1

The obvious enemy to a clear communication with the public is jargon.[3] As scientists, we are guilty of slipping back into it all too often, sometimes involuntarily. The above two examples were cases of scientists writing for or talking to their colleagues, and so in fairness they might not necessarily be expected to use language that a non-specialist would understand. But fundamental science being funded with taxpayers' money, it is a duty for the professional scientist to engage the public in a two-way discussion about their work, its objectives and the very reason of its being. The first obstacle to this aim is jargon.

As an astrophysicist with a passion for communicating with the public, I have been looking for novel ways of engaging new audiences with my science. For over a decade, I gave public lectures to a wide variety of audiences; I worked with filmmakers, artists, designers and architects to create videos, artwork and installations inspired by cosmological ideas; most recently, as part of a Science and Technology Facilities Council public engagement fellowship I was awarded, I have been using cookery and food to approach astrophysics and cosmology with young audiences in a hands-on way. My partners at Kitchen Theory and myself are now working on taking this notion one step further and are developing an idea for an astronomy lecture for visually impaired people entirely based on food and sensorial experiences other than sight.

All this time - I now realise - what I was searching for was a language to translate in a more pictorial, immediate way the often complex and abstruse cosmological concepts my research is about: dark matter, dark energy, the Big Bang and the fundamental nature of the universe. A language that would speak not only to people's minds, but most importantly to their hearts.

Inspirational examples of this can often be found in astronomy, perhaps because its breath-taking beauty lends itself well to engaging our emotions as well as our brains. Andrew Fraknoi gives a surprising survey of how much astronomy has seeped into fiction, drama and poetry.[4] Some of my personal

[3] Aviv J. Sharon, A. Baram-Tsbari, 'Measuring mumbo jumbo: A preliminary quantification of the use of jargon in science communication', Public Understanding of Science, 23, 5, 528-546, 2014; K. Hinko, J. Seneca & N. Finkelstein, 'Use of scientific Language by University Physics Students Communicating to the Public', in: Physics Education Research Conference Proceedings 2014, P.V. Engelhardt, A. Churukian and D.L. Jones (Eds), PER Conference series. Minneapolis, MN: July 30-31, 2014, 115-118.

[4] Andrew Fraknoi, 'Interdisciplinary approaches to astronomy: Cosmic fiction, drama

favourites are the poetry of Simon Barraclough (Poet in Residence at the Mullard Space Science Laboratory)[5], Nick Payne's play *Constellations* (aptly mixing the multiverse, love and the meaning of life) and the cosmologically inspired sculptures of Josiah McElheny (produced in collaboration with astrophysicist David Weinberg).[6] In trying to devise a similarly touching way of talking about my subject, my hope was to tear down the barrier to a genuine two-way dialogue that is the technical knowledge gap between the science professionals and the public.

Less is more

In the back of my mind I had the apocryphal story I once heard about a bet made by Ernest Hemingway. It is recounted that one night, around a dinner table, his friends challenged him to write a novel with only six words. After a moment of reflection, the great novelist grabbed a napkin and on it he wrote: 'For sale: baby shoes, never worn'. His friends readily conceded the bet.

I loved the immediacy of what would later be called 'flash-fiction': its economy of words left space for the readers' imagination to fill in the gaps -- indeed it demanded it. Somehow, this seemed to promote a stronger, more active engagement from the part of the reader. Today, the genre has evolved in a number of different ways, including the Six-Word Story (in homage to Hemingway's six-worder) the drabble (word count limited to one hundred), and of course, Twitter-based storytelling (David Mitchell's 'The Right Sort' short story was narrated over 280 tweets sent in the course of a week[7]).

'Was it possible to achieve something similar with science?,' I asked myself. It was clear to me that the flash-fiction format would require to pare down ideas to their absolute essence, thereby hopefully helping their quintessential meaning to shine through more brightly.

Then one day in January 2013 I stumbled on the web on the Ten-Hundred Words of Science challenge -- a website collecting people's descriptions of their job written using only the most-used 1,000 words in English[8].

The format had come from a cartoon by Randall Munroe, the creator of the XKCD website. This is a humorous site with original, geeky stick-like cartoons,

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and poetry', Communicating Astronomy to the Public Journal, 18, Sept 2015, 7-11.

[5] Simon Barraclough, *Sunspots*, London: Penned in the Margins: 2015

[6] David Weinberg, 'The glass universe: Where astronomy meets art', *New Scientist*, Dec 6th 2008, 2685.

[7] David Mitchell, 'The Right Sort', online: https://www.theguardian.com/books/2014/jul/14/the-right-sort-david-mitchells-twitter-short-story (accessed Jan 4th 2017)

[8] Ten Hundred Words of Science, online: http://tenhundredwordsofscience.tumblr.com accessed Jan 4th 2017.

often revolving around physics, maths, computer science and other technical subjects. Randall had drawn a picture of the Saturn V moon rocket (or 'Up-Goer Five') , and labelled its parts using only the 1,000 words list.[9]

For example, in this Sspartan vocabulary the escape pod had become 'Thing to help people escape really fast if there is a problem and everything is on fire so they decide not to go to space'. I could see that this could be fun.

I spent a frustrating hour writing up my job with the 1,000 words lexicon, and I found it harder than I had imagined. I posted a copy on my website, then forgot about it. The next month I gave a public talk at the White Building, an art venue in East London. The person who introduced me mentioned that he had found this unusual description on my website, and a member of the audience brought this up at the end -- what was this business with the 1,000 words about, exactly? I read out the couple of paragraphs I had written:

> I study tiny bits of matter that are all around us but that we can not see, which we call dark matter. We know dark matter is out there because it changes the way other big far-away things move, such as stars, and Star Crowds. We want to understand what dark matter is made of because it could tell us about where everything around us came from and what will happen next.
>
> To study dark matter, people like me use big things that have taken lots of money, thought and people to build. Some of those things fly way above us. Some are deep inside the ground. Some are large rings that make tiny pieces of normal matter kiss each other as they fly around very, very fast – almost as fast as light. We hope that we can hear the whisper of dark matter if we listen very carefully. We take all the whispers from all the listening things and we put them together in our computers. We use big computers to do this, as there are lots and lots of tiny whispers we need to look at.
>
> I go to places all over the world to talk to other people like me, as together we can think better and work faster. Together, perhaps we can even find new, better ways to listen to dark matter. Most of them are good people, and after we talked we go out and have a drink and talk some more.

I was surprised by the unexpectedly strong, positive reaction of the audience. That got me thinking: perhaps this was the new language that I had been looking for! And perhaps it could even be used to talk about everything in the Universe, not just my job. My book, *The Edge of the Sky* is the result of that small Eureka moment.[10]

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[9] Online: http://splasho.com/upgoer5/phpspellcheck/dictionaries/1000.dicin (accessed Jan 4th 2017); Munroe, R., (2012) 'Up Goer Five' Nov 12th, 2012, available from: https://xkcd.com/1133/ (Accessed Apr 5th 2016)

[10] Roberto Trotta, (2014) 'The Edge of the Sky: All you Need to Know about the All-There-Is', New York: Basic Books.

A new language

Over the next three months, I dutifully sat down at my desk at the University of California Santa Barbara (where I was free of teaching duties during a research stay) and spent some time every day wrangling with the difficulty of talking about the Universe using only the most common 1,000 words.

The first hurdle was to find a new word for 'Universe', which was not in the list. So it became the 'All-There-Is'. A 'planet' became a 'Crazy Star'; a telescope, a 'Big-Seer'; scientists were 'Student-People'; our galaxy 'the White Road', the 'Big Bang' the 'Big Flash' (after my editor vetoed my earlier choice, the 'Hot Flash'!) and other galaxies became 'Star Crowds'.

As this new language started to emerge, little by little a new voice took over. A voice that I had not anticipated, and that was created by the poetic straitjacket imposed on me by my chosen format.

Not only did I find that limiting my lexicon to the most-used 1,000 words swept the table clean of jargon (as I was sure it would): it also forced me to think afresh about seemingly familiar concepts, and how to describe them in a more pictorial, metaphorical way. It gave me a fresh, childlike perspective on the Universe. I realised that this is particularly important when talking about concepts that might be familiar to us, the professional practitioners of our discipline, but that are very far-removed from the everyday experience of the general public. We tend to get lulled into a false sense of comfort, by using terms that we mistakenly believe non-scientists understand the same way we do, like 'galaxy', or 'electron' or 'black hole'. So why not get rid of all those words and use instead simple language that everybody can understand?

The All-There-Is in 707 different words

In the *The Edge of the Sky,* I've tried to follow Einstein's advice, who reportedly once said: 'You do not really understand something unless you can explain it to your grandmother' -- and a mere 707 words from the 1,000 words list is all that I ended up using to do that. The book tells the story of a Student-Woman who spends a night observing far-away Star Crowds with the help of Big-Seer, looking for dark matter:

> She steps outside in the cold night, holding her cup of hot coffee with both hands.
>
> The White Road is beautiful in the dark, clear sky, and, once again, she can not help but be amazed by it all.
>
> It does not matter how many times she has seen this before, or how much she knows about what is out there. The sight of the stars is enough to make her gasp.

> 'It all seems so still and yet it's changing all the time,' she whispers to no one.
>
> It is hard to believe that everything out there past the White Road and its stars is running away from us.

Yet, like Mr Hubble found long ago, the Star-Crowds are running away from each other, as the space between them gets bigger and bigger. The All-There-Is is growing with time.

From sunset to sunrise, we follow her as she reflects about our Home-World and the other Crazy Stars around the Sun, and the many more that go around far-away stars; the way the All-There-Is grows, and how it began in a Big Flash; and all the questions we still have on it, like dark matter, the Dark Push and the existence of other kinds of All-There-Is.
Whether or not *The Edge of the Sky* succeeded in its goal is a question that only my readers can answer. From my perspective, writing the book has been a fascinating challenge that brought up questions I had never considered before. That meant re-thinking my understanding of concepts I thought I grasped -- I had to see them with new eyes, and I hope this perspective shines through in the book. Perhaps the hardest part was how to talk about the early Universe, when none of the words I would normally have used (such as 'particle', 'energy', 'speed' or even 'soup'!) were available. Or indeed at times I felt that abiding by my own rules was generating verbosity rather than the concision I was after, for example in the following passage, where there is a table 'with a large number of small gray round pieces on it – of the type that you can use to buy a coffee, or a paper, or to pay for parking. The ones with one head on one side and some other picture on the flip side'. In short, coins. With some distance now, I have come to see the language of the book as a sort of post-apocalyptic tongue. One could imagine a bunch of survivors recounting stories around a fire, at a time when all the details have been forgotten, and only the core images remain.

If the book will help some of my readers connect with some of the complex ideas of modern cosmology and generate curiosity and enthusiasm for fundamental science, my aim will be achieved.

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